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Evaluation of a Five Node Videoconference System and Shared Graphics Workspace - U.S. Department of Defense, Washington D.C.

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EVALUATION OF A FIVE NODE VIDEOCONFERENCE SYSTEM AND SHARED GRAPHICS WORKSPACE - U.S. DEPARTMENT OF DEFENSE, WASHINGTON D.C.

CONTENTS

1. INTRODUCTION

This report describes the results of an evaluation exercise carried out by the author for the Defense Advanced Research Projects Agency (DARPA) of the U.S. Department of Defense. The equipment being examined was a five node videoconference system located in Arlington, Virginia. One studio was in the DARPA building, the other four being in the nearby offices of two Department of Defense contractors. This exercise took place over a three to four week period in June, 1983. In addition, comparisons are made with the results of an earlier evaluation exercise carried out by EIU Informatics for DARPA. This earlier study took place in 1982 on a US Air Force Base in San Antonio, Texas.

The research looked at the system's suitability for, and effect on, meetings held as videoconferences. In addition much effort was spent publicising the trial and demonstrating the equipment to various Defense Department agencies interested in videoconferencing. Using a videoconference system people from two or more sites can hold a meeting without necessarily having to travel to meet in one place. However, videoconferences need not only act as substitutes for face to face meetings, but can also supplement them. Extra interim meetings can be cost justified which otherwise would not be feasible, such as short project meetings involving a lot of people. Other advantages of teleconferences are that they are reliable and can quickly be arranged. By introducing teleconference systems throughout the Defense Department, the flow of information and its effectiveness can be improved.

Personnel who took part in the research and held meetings on the system included volunteers from the Department of Defense and experts in the field of teleconferencing. They were able to see a very compressed motion video image of each other's face, using codecs produced by Compression Laboratories Inc. In addition, they could access and create graphical and textual information via a shared graphics work space (SGWS) produced by Computer Systems Management Inc.

The equipment used in this research is notable for a number of reasons. The video signals work at data rates of 19.2 Kbit/s. Five studios are fully interconnected and all the participants can see each other the whole time. Each participant has the power to decide what is displayed via the SGWS at each site and everything drawn by any of them is immediately visible at each of the other sites. Furthermore, the video system is configured so as to create a simulation of a round-the-table meeting in which each participant can see who it is each other is looking at.

2. SUMMARY

This chapter briefly summarises the results of this evaluation exercise carried out for DARPA by EIU Informatics. The twenty sessions held on the system and in particular the six 'real' meetings were by and large very successfully carried out. The real meetings were normal work meetings scheduled to take place over the videoconference system. They were mainly co-operative discussions or presentations of ideas although with an element of problem solving and the need to generate ideas. The system was not thought satisfactory, however, for certain types of meetings. One example was an opportunity for two groups to examine possible areas of overlap between their two areas of research but had no clear immediate objective. This meeting was cut short without any real discussion having been achieved. Other participants felt that the system would not be very suitable for training or for highly emotive meetings, especially those between people of widely differing rank, but would be suitable for project meetings involving peer groups.

Comparing their first experience of a videoconference with their normal face to face meetings users agreed that people were more co-operative, task orientated and less aggressive. However other aspects were less clearly agreed upon. <u>Similar numbers felt it had been more satisfactory to themselves as felt it had been less so.</u> There were users who felt it gave them more control over the meeting and those who felt it gave them less. In conclusion the system was thought to be adequate for many purposes, but is probably not attractive enough to guarantee its success throughout the Defense Department. In particular, more non-technical users would be prone to compare it unfavourably with 'normal' broadcast TV and might not appreciate its sophistication. The following are a number of points which need attention if the system is to be implemented widely and successfully. However, the list is a short one and the overall impression given by the agencies participating in this exercise was very favourable.

Points needing attention include:-

- The quality of the image produced by the sketch coders. This is the main source of dissatisfaction. Newer codecs, such as Widcom's, are much preferred and should be recommended even at the increased price.

- The loss of synchronisation between lip movements and speech caused by the delays in the video signal was disliked.

- The virtual space arrangement works very well. In normal face to face meetings people commonly append someone's name to a remark for emphasis or to direct it specifically at them. In teleconferences in general the incidence of such name tagging is often increased since people can not rely on alternative visual procedures, such a person's direction of eye gaze or orientation. However, less than three percent of comments were thus name tagged and no problems were encountered concerning who is speaking and to whom. However, the extra cost of providing such an effect is considerable and other ways round the problem should be examined. In particular an alternative technique was used in a system developed by members of EIU Informatics for DARPA in 1981. This could utilise only one transmitting codec and camera per site.

- Keeping participants in camera shot is a major problem. Self view monitors would only help those motivated to remain in view. Otherwise, if it is necessary that someone remains visible to all even when he, or she sits back in the chair, for instance, then operator controlled moveable cameras are required.

- The videoconference system is at present designed for one person per site. More than one person cannot be positioned so as to be clearly in view of all four cameras. It is desirable to be able to switch to a fifth camera in each room which would transmit an identical group image of a room's participants to each of the remote sites.

- When less than five sites are involved in a videoconference the virtual space should be adjusted in each room so as to maximise use of the central two columns in preference to the outer ones while still maintaining a consistent sequence of participants.

- The audio quality is unsatisfactory. In developing the video side of things care should be taken not to forget the more 'mundane' audio system. Even in the quiet environments enjoyed by this trial, problems were encountered with howlaround and the general sound

level. In noisier strategic environments it is vital that not only are the studios designed to cut down any extraneous noises but also the treatment within the rooms and the design of the audio system be improved. The spatial separation of the loudspeakers is however very valuable for a participant to be able to detect quickly and easily who is speaking.

- The private audio system is little used, but is nevertheless a valuable accessory to videoconferences and should be retained.

The Shared Graphics Work Space (SGWS) is generally very successful and easy to use. Its possible advantages are more easily apparent to prospective users than are those of the videoconference system as a whole. There were users who could see a role for the SGWS, but not for the remainder of the equipment. There are a few points wich need attention e.g.:-

- Each participant's actions should be identifiable by display of their, or their site's, initials alongside their stylus's current position.

- It is not obvious to a user when he, or she, is in indicate as opposed to writing mode.

- The 'next page' and 'last page' functions need to be able to cope with multiple requests by a single user (eg move five pages forward, when quickly tapped five times). They should not be simultaneously responsive to all users. A delay of a few seconds is necessary before a second user's request to change the page being displayed is accepted and acted upon (e.g. a second person should have to wait until the current status has been established).

- A senior user, or chairman, should be able to lock the system so that only he, or she, can change the page number being displayed.

- The positioning of the workstation needs to be improved. At present it is too low, too far to one side and suffers from glare off the surface of the screen.

- Twenty pages of buffer is not an adequate number for many purposes.

- Facsimile and word processor interfaces should be provided. The means by which all types of pages may be prepared needs to be developed so that all procedures are user friendly and menu driven.

- A second SGWS monitor is required for use by any observers in a meeting.

One particular concern expressed by the agencies represented during this exercise was that the codecs, especially, might soon become obsolete and that any network implemented would be incompatible with later videoconference systems. They would like, in general, for a videoconference network to be flexible enough to be able to incorporate new components or technologies as and when they became available. This problem is exacerbated by the long lead time necessary to detail equipment procurements which is itself long enough for the state of the art technology to have changed significantly. These are problems which are associated with the introduction of all technologies, especially in the field of telecommunications. While early users help develop and test the technologies, there is an attraction for an organisation to wait until the optimal design and configuration and its usefulness have been firmly established. Subsequent users can also then take advantage of lower prices since mass production techniques can be applied on a large production run, whereas prototypes may be individually designed and made largely by hand. The problem with developing telecommunications equipment is made worse by the fact that such equipment is only really attractive when there is above a critical number of terminals in existence with which one can communicate.

It is because of these effects that the role of DARPA is so critical for the development and introduction of videoconferencing within the Defense Department. The cost of such equipment to prospective Defense Department agencies should in the first instance be minimised in recognition of their help in developing and testing the equipment and building up a critical user population. However, this development role requires there to be a feedback mechanism to the manufacturer. The current evaluation exercise is such an opportunity for the manufacturers to benefit from the users' experience with the equipment used in the context for which it was

designed. However, this feedback process should be continued using short questionnaires. These should be completed by participants after the systems are eventually installed. As users become accustomed to using it as part of the normal working practice they will undoubtedly have useful comments to make about any changes which should be made or features which should be added so as to maximise its usefulness to the Defense Department.

3. DESCRIPTION OF THE VIDEOCONFERENCE SYSTEM

3.1 Compressed video and room design

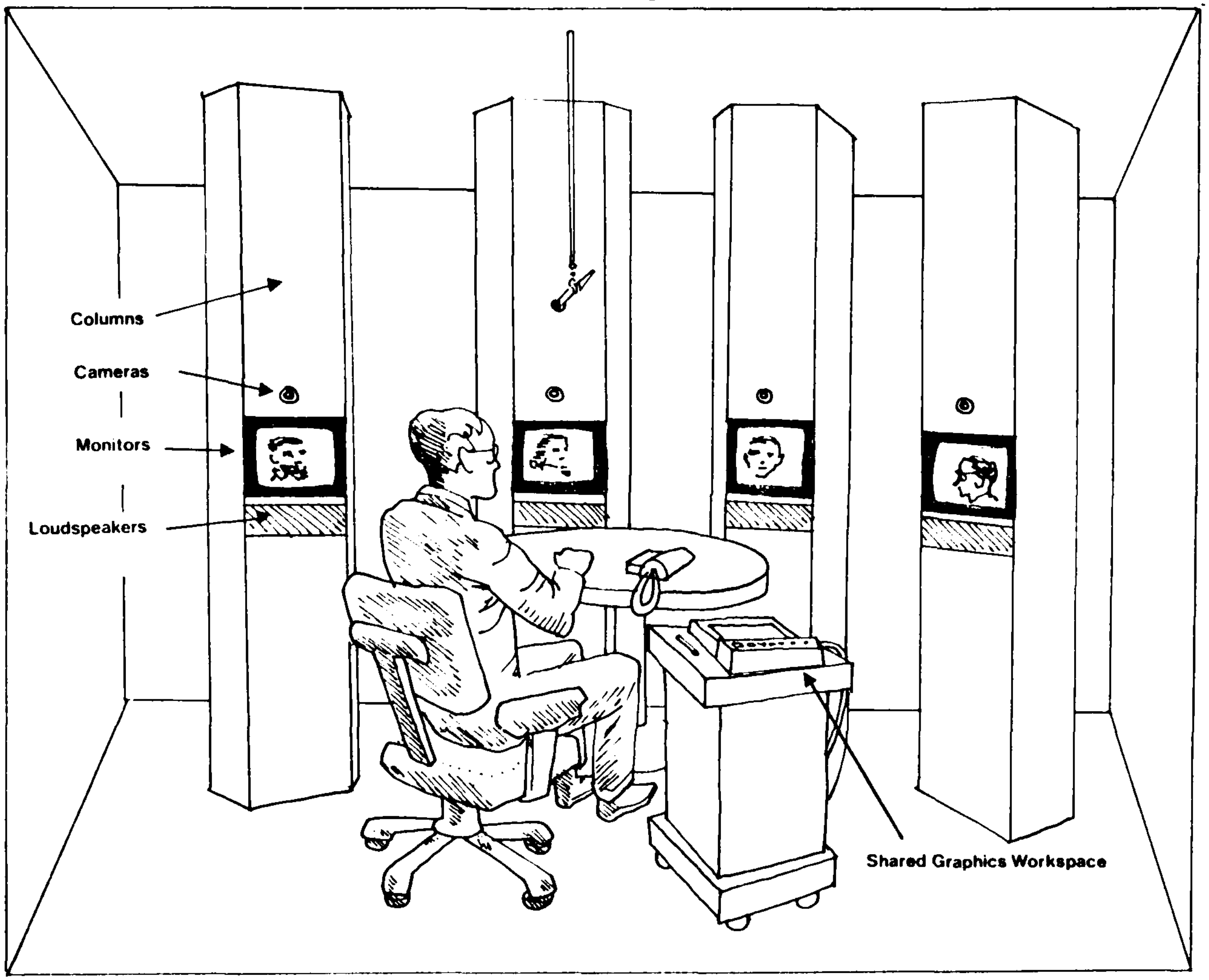
Each of the five studios is designed for one active participant. Additional observers can observe and listen to what is going on, but can only be heard and not be seen by the remote participants. As shown in figures 1 and 2, a conferee may be seated at the table in front of the four columns arranged in an arc. Each column contains the video monitor and loudspeaker associated with one of the other four rooms. In addition each column also contains a camera which relays a view of the local participant to the same remote participant whose image is displayed on that column. To one side of the conferee is the shared graphics work space (SGWS) module with a display monitor mounted horizontally in the top.

There are some differences between the five rooms. One is situated by itself in the DARPA building. The other four are in two nearby Defense Department contractors' offices. Three rooms have windows, the other two do not. The sizes of the rooms vary from about ten feet by ten feet to about twenty feet by twelve.

In addition, the tables range from a three foot six inch diameter round one to a large ten foot long purpose built one. The exact shape and finish of the columns also varies. However, factors such as height of the monitors and angle subtended by them (about 35° to 40°) are kept constant from room to room.

Digital cable TV signals can transmit at rates of about 45 Mbit/s. By comparison the video image used in this system required data rates of only 19.2 Kbit/s a factor of over a thousand times less. This compression of the video signal is achieved by 'Sketch Coders' at the expense of the quality of the video image. Both the temporal and spatial resolution are reduced. The image changes approximately eight times a second and is approximately 120 Pels. The individual picture elements are much larger than for broadcast television and are easily discernible. There is no colour, nor any grey scale. The resulting image is one in which edges and changes in contrast level are portrayed as black lines on an otherwise white background.

Figure 1. A View of one of the Videoconference Studios



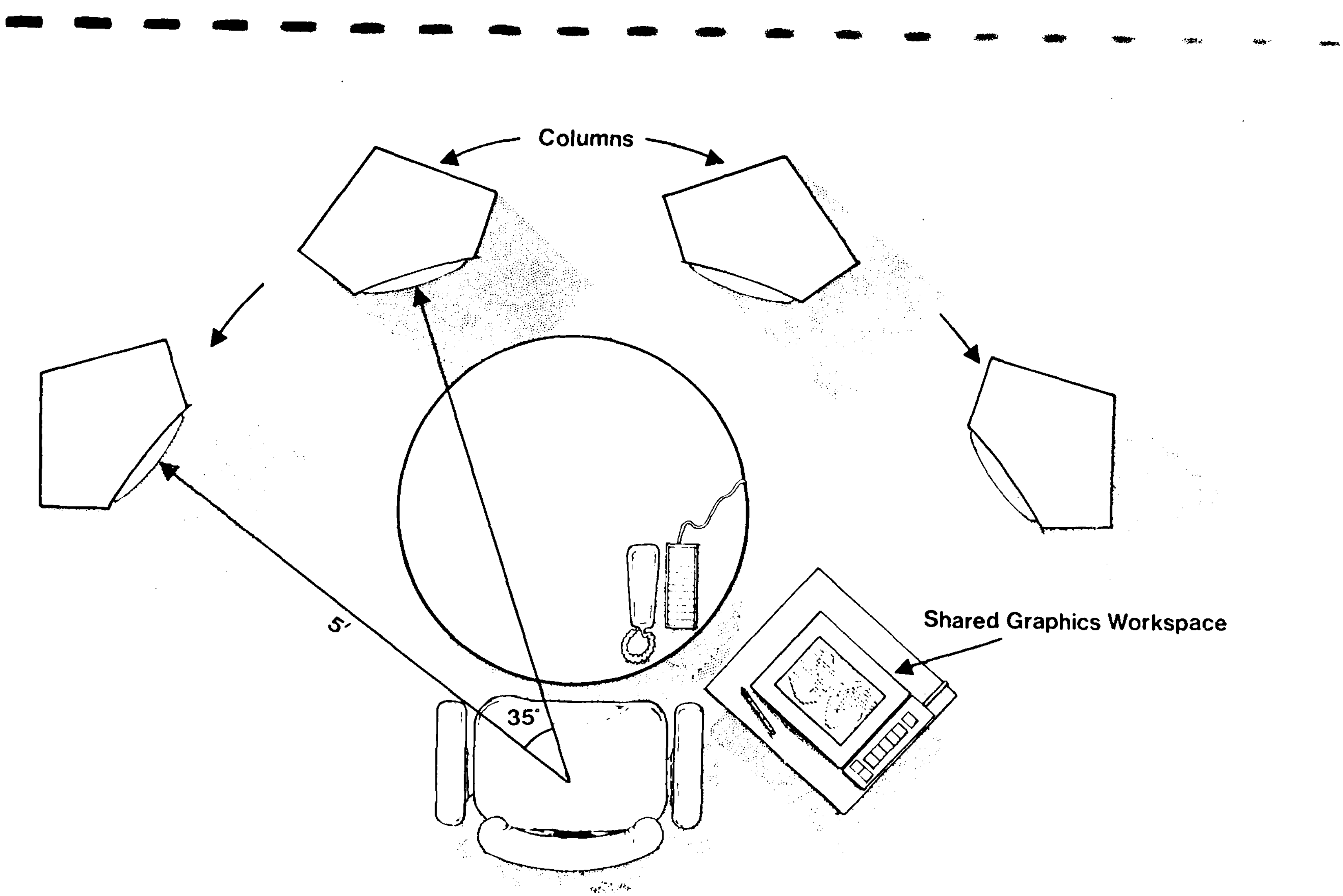


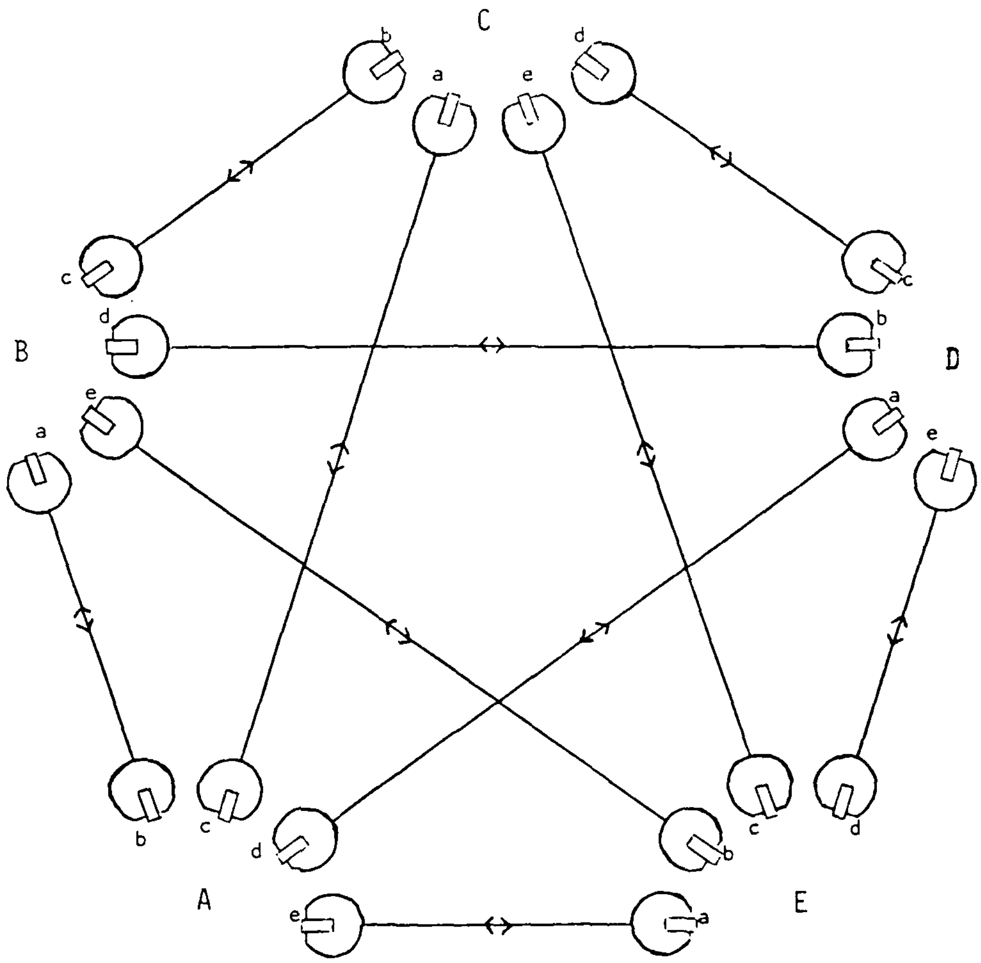
Figure 2. A Plan View of a Studio

One reason for compressing the video image is to cut down on transmission costs. This is the main reason behind the popularity, among commercial videoconference users, of codecs working at 1.544 Mbit/s. Such a compression ratio of about three per cent has a relatively minor effect on picture quality. DARPA, while also wanting to minimise transmission costs, had two additional reasons for developing the 19.2 Kbit/s codecs used in this exercise. Reducing the transmission rate to this low level enables the signal to be easily encrypted by standard data encryption devices and minimises the possibility of disruptions due to atmospheric disturbances.

As has already been mentioned, this trial videoconference system is also unique in that more than two sites are in full communications with each other. While several organisations do have videoconference networks, these are configured so that only two or at most three sites may be fully interconnected at any one time. When multiple sites need to be connected, the video signal from one main site is typically broadcast one way to each of the others. These minor sites can only be heard and not seen.

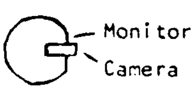
Figure 3 shows a simplified diagram of the interconnections between cameras and monitors. Each line represents a pair of camera-monitor links, one going in either direction. The five sites and participants are labelled A to E. Each site has four pairs of cameras and monitors. These monitors are here labelled (a to e) according to the identity of the image displayed on them. At each site, the sequence of the local participant and four displays is in a consistent order, i.e. A is always on B's right, who is always on C's right, who is on D's right, who is on E's right, who is on A's right. The same virtual round the table ring of conferees is thus created at each site. The view each remote participant sees of a particular studio is that transmitted by the camera above the monitor where their own image is displayed. Therefore B's view of A, for instance, will usually be of A's left side, just as if they really were seated next to each other round the table. When A looks at B's monitor, A looks into the camera transmitting to B and it appears to B as if A is looking right at him, or her. At the same time all the other users see A looking to his, or her, left across at B.

Figure 3 Interconnection of the video system in a five node virtual space videoconference system



A - Site / Participant

a - Identity of displayed image on monitor



Throughout the meeting the participants are always in complete visual contact. All the participants can see who it is each other is looking at. When someone talks at a particular monitor that person sees him, or her, looking straight at them. While the above explanation may seem complicated, users may remain completely unaware of the technical complexity and that there are, for instance, four cameras at each site and twenty different signals being transmitted over the system. The users' reactions to this virtual space concept are discussed in Chapter 6.

The actual way the five sites were interconnected in the exercise was not as shown in Figure 3. In fact the three sites were connected in series. Between each site the four video signals, the audio and the SGWS were multiplexed onto two digital 56 Kbit/s lines provided by the local telephone company. At each of the three sites, the codecs, videodisc players and other related equipment are located in a separate room. From these rooms the three operators can set up the teleconference and close it down. Using a monitor an operator can view each of the incoming video signals, check contrast levels and make any adjustments necessary. The main audio system can be similarly monitored from these control rooms.

3.2 Audio System

Four loudspeakers are located in the four columns. Each one transmits the speech from one of the four remote sites and is located underneath the respective monitor. Users can thus also use the spatial separation of the speakers to help locate who is saying what. The microphone is a directional shotgun microphone hanging from the ceiling in front of the participant and is directed towards him or her.

The audio system is a completely open one. All the users can speak and be heard at the same time. In order to do this, certain precautions need to be taken against 'howlaround'. In an open system any sound leaving the loudspeakers is picked up by the microphone in the same room, amplified and then relayed to the other rooms where it can again be picked by the microphones there and pass back through the audio system. If on every cycle the amplification is greater than the loss between the loudspeakers and microphones, then the positive feedback results in a loud howl soon swamping the system. It is therefore necessary to minimise the amount of sound picked up by the microphones from the loudspeakers in the same room, while maximising that originating directly from the participant.

The directional microphones are most sensitive to sound originating from in front of them and thus do not pick up sound directly from the loudspeakers behind. It is however necessary to minimise the amount of sound reflected off the walls, especially the one behind each participant, which may otherwise be picked up indirectly by the microphones.

The general level of sound needs to be moderated because of the concerns with feedback. However another side effect of multisite systems would tend to promote use of higher than normal sound levels. Due to the fact that there are five live microphones, the ambient background noise makes it more difficult to comprehend what is being said than in a two node system with only two live microphones. Effort therefore has to be made to minimise the impact of all extraneous sound sources.

Each studio is also equipped with a local telco telephone. The handsets can store ten phone numbers which can then be automatically dialled by simply keying one of the ten keys. In each room, four keys are set up to dial the four remote sites. These are labelled and arranged so that their order corresponds with the sequence of monitors. By simply lifting the handset and touching the respective key one user can be connected with another, once he, or she, has also lifted their handset. Since as soon as someone lifts their handset their overhead microphone is also cut off, these conversations are private and can not be overheard. However, the loudspeakers and the other microphones remain live and so the two people having a private conversation can continue also to listen to the general discussion and thus not miss something important. Other outside numbers can be simply dialled in the usual way.

3.3 Shared Graphics Work Space

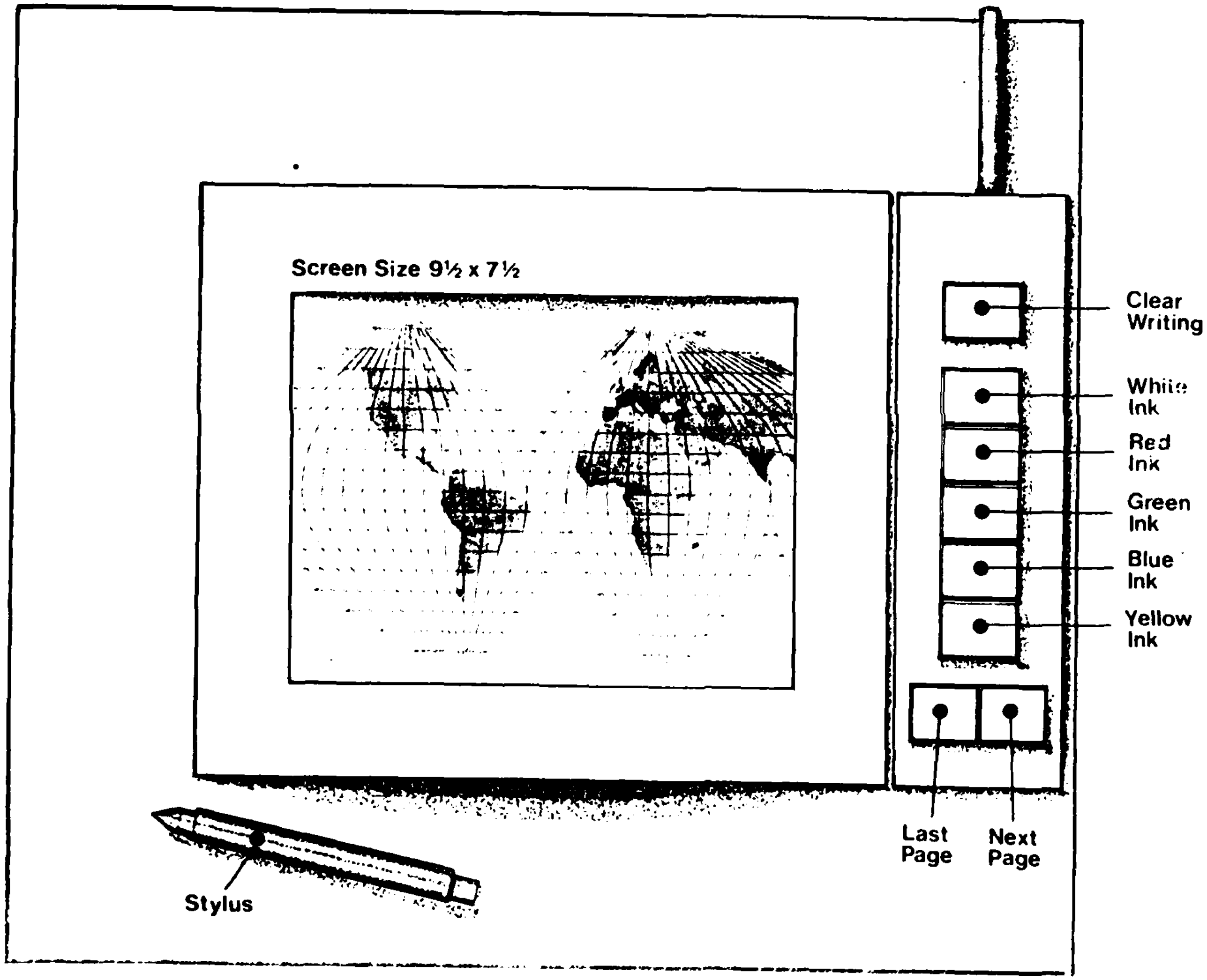
The Shared Graphics Work Space (SGWS) is operated from the console beside the participant. A view of this console is shown in figure 4. Its surface is at a height suitable for writing and, since it is on casters, can be positioned on either side so as to be easily usable by left and right handed personnel. In the top of the console there is a horizontally aligned monitor screen with a touch sensitive surface. To one side of this screen is an array of self illuminating control buttons. These again can be placed to either side of the screen, according to individual preference.

The SGWS can be used to display up to twenty frames which can either be blank or prepared beforehand and stored on the system. Colour Videodisc frames can be displayed on the system and these can be overlaid by text or graphics created at a central workstation. Any user can control which particular frame is displayed and each frame is automatically displayed simultaneously at all five nodes.

During a meeting these frames can be drawn upon or over-written by the users themselves, using a simple stylus and any one of five colours. Again everything drawn by one user is automatically and simultaneously displayed at all the sites. All the users can be simultaneously drawing in the same or different colours.

The operation of the SGWS by the user has deliberately been kept simple. In order to move from frame to frame, any user can touch either the 'next page' or 'last page' button. Each frame has its page number indicated in the top right hand corner and so the users can follow whereabouts they are in the twenty page database. In order to write on the screen, a user first selects a colour, by touching one of the five colour buttons, and then draws on the screen using the stylus. In order to change colour a user can touch another button whereupon it will light up. Any annotations are automatically saved when a user changes the page being displayed.

Figure 4. The Shared Graphics Workspace



If a user touches a particular colour button twice, then the system passes into an indicate mode. Pressure on the screen then results in an indicator ⟨⟩ following the position of the stylus on the screen. Therefore a user can use this to point at an item or area and all sites can see where he, or she, is referring to. In order to erase a line, any user can retrace over it with the stylus while having held down a button on a second separate small box on the console. This function was to be effected by retracing over a line while simply using the other end of the stylus. Reversing the stylus would activate a microswitch and would do away with the need to hold down a button. However this feature had not yet been implemented at the time of this trial. In order to erase all the annotations on a particular page, a participant may alternatively simply key the 'clear writing' key.

Each station is equipped with a videodisc player. Prior to a meeting, the SGWS can be set up so that a videodisc frame is associated with any of the 20 available pages on the system. Whenever such a page is then accessed, the relevant videodisc frame is displayed on the SGWS monitors. The players are synchronised so that the same frame is displayed at each station. The actual frame is not transmitted round the ring, but its frame number is. So, therefore, each site must be issued with an identical copy of the videodisc prior to the meeting.

The disc used in this exercise is one containing about 30,000 frames. These comprised detailed views of a complete map of the world, at four different scale levels, and photographs of Soviet naval shipping. The interactive potential of videodiscs driven by a computer is illustrated by a capability built into the system. It is possible at a central control terminal, by merely keying in the name of a town or city, to have the relevant map displayed automatically at each of the SGWS workstations.

The SGWS workstations are connected in a ring. Information about any commands executed by the users is transmitted round this ring at a rate of 1.2Kbit/s. This signal is multiplexed with that for the video over standard 56Kbit/s digital lines.

It is intended to allow the users to introduce frames on the system by way of a fascimile device. This would enable a user to bring hard copy diagrams to the videoconference and put them on the system. They would then be displayed at all the sites, and the participants would be able to annotate them if necessary. This development had not been implemented at the time of the trial. Another possible enhancement to the SGVS would enable users to access information from external databases during their videoconference.

4. RESEARCH METHODOLOGY

This research followed on from a three week evaluation of a two node videoconference system at the Randolph Air Force in San Antonio Texas at the end of 1982[1]. This US Air Force system has now been reconfigured so as to link San Antonio to the Pentagon. The two videoconference systems are similar in that the same type of codecs are used. However, the number of sites differ; the San Antonio system has only one codec at each of two sites whereas the Washington D.C. system uses four codecs at each of the five sites. The Washington D.C. system is primarily designed for one person per site, while users of the San Antonio system are able to switch to a three person view of a remote site. Particular attention was made here to the use of the virtual space concept in multi-node videoconferencing. Two different SGWS systems have been tested. Users interacted with the San Antonio system via the two writing tablets and a touch sensitive screen mounted in the table at each site. In the Washington system a single touch sensitive screen was mounted in a moveable console which could be positioned on either side of the participant.

The research examined the following objectives:-

- to evaluate multi-site videoconferencing in a real setting
- to gather users' reactions to virtual space and to an extremely compressed video signal
- to gain information on the use made of and problems associated with the Shared Graphics Work Space
- to demonstrate to and gather responses from Defense Department agencies considering videoconferencing
- to gain information on the forms of information and graphics commonly used by agencies in their normal meetings

[1] Patrick White 'AN EVALUATION OF VERY COMPRESSED VIDEOCONFERENCING AND A SHARED GRAPHICS WORK SPACE - AIR FORCE MANPOWER AND PERSONNEL CENTER, SAN ANTONIO, January 1983.

The original methodology put forward by EIU Informatics in their proposal for this work contained the following two phases:

- The study of twenty simulated and real meetings over six weeks using both the San Antonio and Arlington videoconference systems. These would involve volunteer Defense Department personnel and would be analysed by the collection of data by direct observation, questionnaires and debriefing discussions.

- The second phase involved studying a series of three to four day long experiments taking place over the Washington system. The purpose of these would be to see whether effective group decision making can be sustained over a period of several days and to illuminate any of the system's deficiences that may only become apparent in such longer meetings. In addition, such studies would identify those behaviour patterns which are artificially created by the novelty of the experience.

Due to time constraints it was not possible to carry out this second phase. By the time the Washington system was in a working state and ready to be evaluated by EIU Informatics, less than four weeks were available before the leasing agreement for the communications links between the five nodes ran out. This remaining time available was still further reduced since some days had to be set aside for fault finding and the implementation of new developments during the evaluation exercise.

A further obstacle encountered by the research was a series of problems with the SGVS system. Only three workstations were in full communication with each other for most of the period up until the last few days when there were four which were fully operable. This meant that the videoconference system was only used by groups who had no need for a graphics facility in order to hold their real meetings and for demonstrations, where one or more people would not have been able to experiment with the SWGS. The author had been prepared to supplement

those real meetings with a large number of simulated meetings using the same discussion task as had been used in San Antonio (SIMeeting). This task was developed in order to encourage participants to hold a discussion with a series of decisions to be made. Participants need to use a graphics facility in order to access stored text and graphics and to create jointly a document on the system. Use of the task was repeatedly postponed as successive faults were identified and remedied.

The result is that there is a general lack of quantitive data for the Washington system, since only relatively few of the sessions held on it were actually meetings as opposed to less valuable demonstrations. Whereas 16 meetings were held on the San Antonio system, only 6 were held on the Washington one. For the purposes of this exercise it would have been preferable to have been better able to back up qualitative judgements made by users and the author with more quantitative evidence. However the information gathered from the fourteen demonstration sessions is still valuable since the participants were encouraged to use all the available facilities and discuss the merits and demerits of the system while each being seated in one of the five studios. The demonstrations were thus more like small meetings where the topic of conversation centered about the system itself and teleconferencing in general.

Over a period of three weeks in Washington the author organised and observed twenty videoconferences. Participants were drawn from Defense Department agencies which had at some time expressed an interest to DARPA in videoconferencing. In addition, several teleconference experts from commercial satellite organisations were also invited to take part in meetings over the system. Overall, for about a third of the participants the videoconference was their first experience of teleconferencing. The average number of participants in each session was between four and five people. However, in some sessions the author sat in on the whole meeting and the number of users who were not drawn from DARPA or from Computers Systems Management, the contractors for the SGVS, was 71. These included personnel from the following agencies and organisations:-

U.S. Navy

U.S. Air Force - HQ
- Communications Command
- TV

U.S. Army - Command and Control Technical Center

Military Traffic Management Control

DCA

DCEC

DRI

NSA

United Nations

COMSAT

Satellite Business Systems

Defense Technical Information Center

Arthur Young

The sessions began with all the participants assembling in one office before then being led off, each to a separate studio, to start the videoconference. This would usually commence with the author explaining some aspects of the system and the purpose of the exercise. The time taken to explain how the system and, in particular, the SGVS worked was short, no longer than five to ten minutes. The demonstration sessions would continue with more detailed discussions about the configuration of the system. The participants' opinions of and attitudes towards the system were collected, both during and after the session, when they again assembled in one room. In the more 'real' meetings, participants would be left alone to proceed by themselves while being observed by the author, out of sight in one of the studios. After these meetings there would be an extensive debriefing session including the use of a questionnaire (Appendix A) to ascertain just what effect the system had had on their meeting and how suitable it was for their purposes. All the meetings lasted between a quarter and three hours, with most of them taking over an hour. In total, the whole process of getting each meeting and its participants organised, the meeting itself and the debriefing session took about two hours on average.

During the 'real' meetings, in particular, the author noted any problems encountered by the users and the flow of the conversation. A paper record was kept of the sequencing of remarks. This shows individual participation levels and notes how the conversation passed from person to person with or without the use of naming to address remarks.

The debriefing sessions, which followed every meeting, examined users' likes and dislikes of the system, their perception of the meeting they had just held and its suitability for their normal types of meetings.

5. ATTITUDES TOWARDS, AND USE MADE OF THE EQUIPMENT

5.1 Compressed video and virtual space

The virtual space arrangement was liked by almost all the participants. All except one of the users had no difficulty in discerning who was saying what and to whom. However, one other did say that it was difficult to keep track of all the monitors when they are spaced apart and that he would have preferred it if they were clustered together. Certainly the maximum possible number was thought to be between five and seven nodes.

Together with the spatial separation of the loudspeakers, virtual space was thought to make for a more natural meeting. Users felt included in a ring of participants rather than excluded as when sitting opposite a central single monitor, or cluster of monitors. Users who had had previous experience of other two node videoconference systems said that this naturalness was helped by the unobtrusive nature of the cameras above each monitor. Some carried out their meeting without ever being aware of where the cameras were, nor that there was four of them. Two people did comment that the columns were too far away and that they should be nearer to the distance at which people sit face to face in a meeting.

In seven of the groups, people commented that a drawback of the virtual space was that people had to remain in camera shot. Instead of having just to sit opposite a single camera, users had to stay at the point where all four camera views coincided. This was felt to be physically constraining and disconcerting because there was no way of checking that oneself was visible to all the remote sites. When others were not visible this was also worrying. There are two points here. One is that staying in camera shot of all of four converging cameras is difficult, especially as a meeting progresses and people slump in their chairs or bend over to read or write. The second point is that there are no self view monitors which would display to each user the image seen of him, or her, by the other sites. At least two and possibly four self-view monitors would be required to confidently position oneself. However, one user commented that when he had previously used systems with self view monitors these had served as distractions and hindered rather than helped the meeting.

Half way through the trial the camera lenses and codecs were adjusted so as to widen the field of view and increase the size of the image in relation to the full size of the display screens. Previously the transmitted image only took up about a quarter of the screen. Since the size of the transmitted image had been increased the refreshment rate was correspondingly slower.

The virtual space should be responsive to the numbers of active nodes connected in a teleconference and maximise use of the more central columns. If there are only three participants in a meeting, for example, the system should readjust itself so that the two remote participants appear on the two central columns in each room while retaining a consistent position side by side. This would avoid situations where two remote participants may appear on the two outer columns while the two central ones remain unused.

The quality of the individual images was not popular. A third of the groups disliked the way the images would be altered slightly on each occasion they were refreshed. Even small areas of stationary objects such as backgrounds would change from black to white and vice versa. Participants would appear on the screens as if they were continually moving. Two thirds of the groups felt the lack of synchronisation between the audio and video signals was a problem. This delay on the video signal is due to the processing time of the coding processes and had been further increased as a result of the steps taken to keep people on camera. The few seconds involved is long enough to lose lip synchronisation. One group gave an example of how it was disquieting to hear laughter, but not to be immediately able to see who was laughing.

The quality of image produced by the Sketch Coders was felt to be adequate by all but two of the groups. These two groups said they would prefer the better resolution of freeze frame at the expense of losing information about the movements of their colleagues. One group said the effect was similar to freeze frame, while the remainder preferred the Sketch Coders to freeze frame and audio only teleconferences. The image quality was reported to be adequate to detect levels of attention and eye gaze but not attitudes, nods or lip and eyebrow movements. Some users said they had deliberately exaggerated smiles etc. so as to be clearly visible to their colleagues. It was possible to identify people already known but not to

get a good feel of strangers. People who met for the first time over the system did though in most cases recognise each other afterwards when meeting face to face. Three groups, while themselves liking the image quality, felt it would be very difficult to sell the idea within their agency, especially to non-technical people who wouldn't appreciate the costs involved in sending a 'normal' broadcast TV type of signal.

The codecs are sensitive to the amount of detail in an image and any changes in contrast. Therefore they have to be adjusted for participants with simple outlines and those with a great deal of detail, such as wavy hair, glasses and striped shirts, for instance. This fine adjustment had to be made to each of the twenty codecs in the three buildings once the users had sat down in the studios. However, the performance of the codecs differed and some were better at maximising the detail portrayed in an image than others. Furthermore, the studios with windows are also subject to fluctuations in the ambient light level as clouds pass by and the sun's position changes and this affects the quality of the displayed images.

If each site only had one monitor this may not have been such a problem. However with multiple images, the result was that there was likely to be considerable variation between the four images seen at each site. This inequality was felt to detract from the round the table feel of the videoconference. Some users wanted to be able themselves to adjust the image quality seen at their site, but the complexity involved in tuning four monitors would be undesirable for most users.

One user provided an illustration of just how people's prior knowledge and expectations can effect their response towards the Sketch Coder and videoconferencing in general. This person had had a lot of experience with a large on-site video system. On his base, briefing sessions too large to be held in one room can be relayed to monitors in up to 10 other rooms in the nearby vicinity. A good quality colour picture can be transmitted via ordinary coaxial cable and amplifiers over the short distances involved. Having been used to seeing 'videoconferences' of such a high quality and not appreciating the complexities and costs involved when the distances are much larger, his opinion of the video side of the Washington system was very derogatory.

Audio System

In most of the meetings there were complaints about the sound. In several, there were problems with howlaround. Apart from these problems which could be alleviated by acoustically treating the rooms there were few other complaints. Only one user complained about the level of background noise.

The audio system was much more frequently criticised by those participants who had held a real meeting over the system. Whereas the visual aspects are most apparent when someone first encounters the system, it is the audio system which becomes most critical once users become accustomed to the system and concentrate not on it, but on their meeting and its objectives.

The spatial separation of the speakers was very well received. Having each voice come from a separate speaker was felt by those, who had experienced group to group two node teleconferencing, to be a great improvement and responsible for much of the success of the five node meetings. The location of individual speakers allows one to identify instantly the source of a new comment.

A side effect of the low sound level was that people felt they had to talk louder than normal and pay attention more to what others were saying. Both of which tended to mean their videoconference was more tiring than a face to face meeting.

The Shared Graphics Work Space (SGWS)

The SGWS was little used during meetings except experimentally, because only three or four of the workstations could be successfully interconnected. In addition there was no way users could themselves enter pre-prepared graphics or text onto the system during or just before the meeting. Notwithstanding the above, the SGWS was felt to be the most useful and widely acceptable component of the videoconference system.

Users who were not confident about the willingness of their colleagues to accept the Sketch Coder images did feel that the SGWS would encounter no such problems.

The main criticism made was the inability to distribute briefing notes, for instance, during a meeting. A fast facsimile device was requested. In addition several groups criticised the position of the SGWS module. This was felt to be too low to be easily written on and also suffered from reflections off the glass surface. One person wanted to be able to go directly from one page to another without having to go through all the intervening ones, displaying them in turn on the screen. He also would like, as a chairman, to be able to lock the system, so that only he could determine which page is to be displayed at all the sites. Thus when giving a presentation he would be confident that someone else could not accidentally or deliberately skip ahead to the next page or pages. All users would still be able to annotate and indicate regions on the particular page being displayed.

In order to draw on the screen a user must press one of the coloured keys. If they press the same key a second time, the system passes into an indicate mode. When he, or she, then touches the screen instead of a line being drawn, an indicator ⟨⟩ appears wherever the stylus is touching the screen. This mechanism for selecting the indicate mode was felt to be unclear. People attempted to write when in indicate mode.

Since all users can write in the same, or different colours, at the same time there was some confusion about who was writing what. In most cases, the users first announced which colour each would then draw with. This was wasteful in that each user ended up only using one colour and a preferable solution was felt to be to have each action labelled. People could be identified by their site name or alternatively be asked to enter their initials, for example, at the beginning of the conference. These labels could then be displayed wherever he, or she, draws a line, writes or indicates, appearing at the position of their stylus on the screen.

The last improvement requested by several users was that there should be a second monitor in each studio displaying the same SGWS image. This monitor should be mounted at a near vertical angle on a portable stand so as to be easily visable to any observers in the room. Otherwise a second or third person present at a site would have to peer over the main participant's shoulder in order to follow what was going on. In general,

several users commented that each site should be better able to cope with more than one person. At present a second person cannot be easily made visable to all remote sites, by sitting alongside the main participant for instance. One user thought that it would be desirable to be able to key in each user's name and then for these captions to be displayed underneath each of the images. Finally, one person criticised the lack of leg room in one of the rooms. One small round table is equipped with a large central column and was evidently too constricting for those with longer legs.

6. THE VIDEOCONFERENCE

6.1 Users' perceptions of the meetings

This chapter looks at, in more detail, the views of those users whose meeting constituted a real example of their normal work. Six such meetings took place involving twenty six people. Their views are extremely valuable since it is only when people have to achieve something from the meeting is the adequacy of the equipment really tested. In addition the discussion does not centre around the equipment itself and it is possible to separate out those things which a more casual observer might feel are important but are largely based on his, or her, prior expectations or arise from the novelty of the equipment. It is possible to confirm whether those things which someone might think are distracting or unsatisfactory are indeed so when they are not the focus of attention. However, all reactions are valuable since it is the initial reaction to a system that often determines whether someone will even give it a try.

The meetings lasted between 15 and 70 minutes once the initial instruction and introductory phase had been completed. The average length was about 50 minutes. After each of the six meetings the users were questioned on type of the meeting they had just held, its suitability for a videoconference and the effect it had had on the meeting. In addition their views were gathered on the equipment they had just used. After four of the meetings questionnaires were completed by the participants. The other two were shorter more general discussions without clear objectives to be reached and therefore it would not have been possible to establish clearly to what degree any such objectives had been fulfilled.

The participants were asked to classify the meeting they had just had in terms of one or more of the attributes shown in Figure 5. Meetings were most commonly thought of as discussions or presentations of ideas, but six did think there had been some element of problem solving and five that there was a component of ideas generation. However, an aspect which may be most sensitive to the novel media, negotiation, was largely absent from the meetings. Participants were cautious about volunteering to hold sensitive meetings on the system at the risk of failure, or achieving an adverse result. This fear may well be carried through to when such systems are used in a real context and result in their not being used for meetings with a high degree of personal commitment.

Figure 5

Components of a meeting which best describe
the participants' videoconference

(four meetings and sixteen participants)

Description	No. of Users	%
Discussion	10	63
Presentation of ideas or views	10	63
Problem solving	6	38
Exchanging information	5	31
Ideas generation	4	25
Negotiation	0	0

In the next part of the questionnaire, respondents were asked to compare the meeting they had just had with their experience of similar face to face ones. On a number of factors which describe a meeting they had to indicate whether there had been an increase or decrease. First they had to indicate which factors they felt were important. The results are shown in Figure 6, together with those for the previous San Antonio study. The most important factors appear to be the effectiveness of the meeting, the co-operation between participants, one's own level of contribution to the meeting and the quality of the decision, or decisions, reached.

Figure 6

Factors Considered by Respondents to be Important in Their Meeting

	% Respondents[1]	% Respondents[2] (San Antonio study)
Effectiveness	100	90
Co-operation of participants	88	85
Own contribution	88	65
Decision Quality	75	87
Information Accessibility	75	83
Own satisfaction with the meeting	69	79
Own control over the meeting	63	48
Sense of privacy/security	63	48
Peoples' preparation	56	77
Task Orientation	44	73
Length of the meeting	44	67
Friendliness of participants	44	70
Aggression of participants	44	45

[1] Total of 4 real meetings and 16 participants.
[2] Total of 16 meetings and 82 participants.

Figure 7 shows how they felt the videoconference had fared in terms of those factors. Half the users reported that the co-operation of their colleagues, which had also been reported as being very important, had been improved. There was considerable dichotomy about whether the meeting had been more satisfactory. About half the participants felt it had been improved while the other half felt it had been made worse. The effectiveness of the meeting, which had also been given as an important factor, was also generally felt to have been impaired. There had been little apparent change in the decision quality and people's own contribution.

Figure 7

Evaluation of Real Videoconference meetings

Factor	No. of Respondents reporting an increase	No. of Respondents reporting a decrease
Co-operation of participants	7 (6)	1 (5)
Own satisfaction	6 (3)	8 (9)
Own control over meeting	5 (4)	4 (7)
Sense of privacy/security	5 (4)	6 (6)
Task orientation	4 (2)	0 (4)
Effectiveness	4 (4)	7 (9)
Decision quality	3 (3)	1 (5)
People's preparation	3 (3)	1 (2)
Own contribution	3 (4)	2 (6)
Length of the meeting	3 (9)	2 (3)
Friendliness of participants	3 (4)	4 (6)
Information accessibility	3 (2)	6 (7)
Aggression of participants	1 (4)	7 (4)

( ) San Antonio Study

Comparing the results of this small sample with that for the San Antonio study, it would appear the Washington system was generally preferred. There was felt to be a higher degree of co-operation between participants, peoples' satisfaction with their meeting was improved and the meetings were much less likely to take longer. It would appear that the virtual space concept may even have advantages for multi participant two node videoconferences, helping the degree of co-operation between all the users rather than allowing a meeting to fall into two sub-groups. The reason for the drop in the reports of videoconferences taking longer is due to the difference between the two SGWS's. The San Antonio SGWS was much criticised for the time it took to display a page and move through the database. There were no major criticisms of the speed of response of the Washington system.

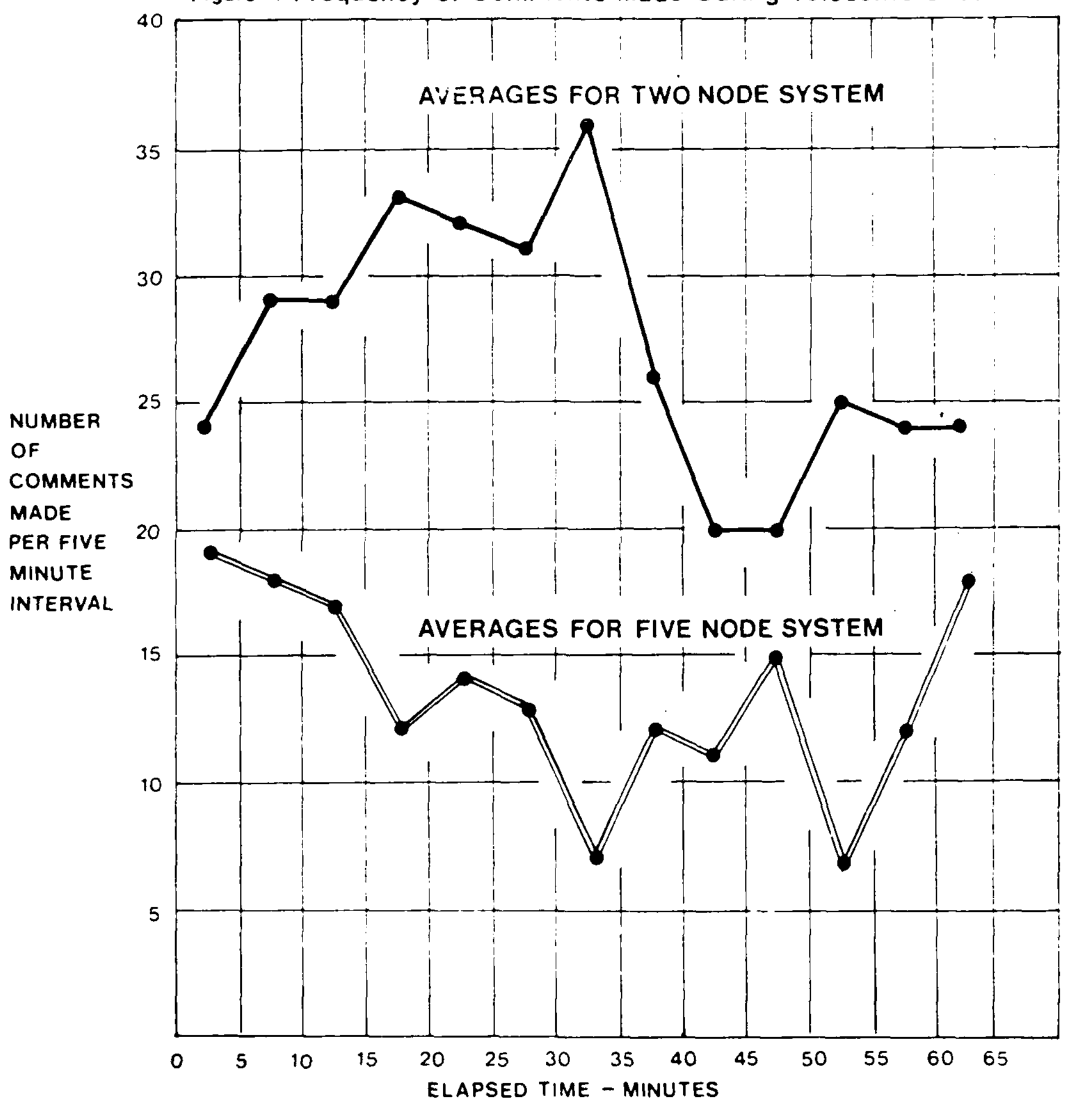
6.2 Meeting Performance

The time taken to learn how to use the system and to feel reasonably confident operating it is minimal. It takes no longer than five to ten minutes to explain how the SGVS works and for the users to experiment using it. A most serious problem was though to ensure that all the participants are seated so as to be clearly visible to each other. As the meetings progressed it was likely that one or more would drift out of the 'sight'of the camera.

A measure of the dynamism of a meeting and the exchange of information is given by the frequency of contributions made by different speakers. Figure 8 shows the average number of changes of speaker during each five minute interval. The two graphs refer to the averages for the seven real meetings in Washington and for fourteen meetings in San Antonio. While in each case the number of meetings observed is small, there does appear to be a difference between meetings held on the five node system and those held on the two node one. In each group of meetings there were very few quiet moments when nobody spoke and therefore the lower figures for the frequency of comments made in the Washington meetings imply that people were making longer individual contributions. This result is borne out by the remarks made by the participants. Although most users said they soon began to forget about the system once the meeting had begun, there were several who said they continued to feel slightly inhibited. They felt they had to plan out their contributions before starting to talk and one said he felt as though he was on the stage when talking. Others commented that there were fewer interruptions than was usual for their normal face to face meetings. For both groups of participants, their videoconferences were novel experiences and thus some inhibition would be expected to wear off as they become accustomed to the procedures.

Section 6.1 indicated how the five node system had been more popular and successful than the two node one. Comparing that result with Figure 8, it would appear that the five node system may be more satisfactory, but at the same time be generally more imposing than the two node system. The users are isolated in separate rooms and do not have the reassurance of being able to talk not always at the system but also to the fellow conferees actually sitting next to them. The difference between the graphs in Figure 8 may merely reflect the fact that the two node videoconferences were in fact a mixture of teleconferences and face to face meetings.

Figure 8. Frequency of Comments Made During Teleconferences



Conferees commented that they felt they had to talk louder and had to concentrate on what others were saying. Some would worry if they missed a few words, while saying that in a face to face meeting they would not be so concerned, reasoning that it was probably not a vital piece of information. They felt they had to consciously look for the reactions of their colleagues. These effects may in part be due to the quality of the audio system making it difficult to hear what others are saying.

A symptom of the heightened task orientation of a videoconference reported in section 6.1 is the lack of any side conversations. This was most evident in one real meeting whose pupose was for two groups to get to know each other and examine areas where their research overlapped They had no other specific objective immediately in mind. This meeting was very unsatisfactory and only lasted ten minutes. Much more benefit in terms of getting to know each other was drawn from the brief time spent together beforehand and afterwards during the debriefing session. It would appear that if there is no clearly identifiable objective, a videoconference can remove all lateral conversations which otherwise allow people gradually to get to know each other and thus removes the opportunity to achieve the work related objective of the meeting which in this case was to discuss directions taken by their research. The result can be a very quiet and embarrassing failure. This meeting was the more remarkable because all the participants were keen to hold the meeting on the system and two had had a great deal of prior experience with it.

The virtual space concept worked well. Only one person felt he had to announce himself before saying something. This he did before each and every comment he made. In total only three percent of the comments were tagged with a conferee's name. When comments were tagged it was usually for emphasis. All the respondents to the questionnaires said that they were able to determine who was saying what to whom. People were able successfully to direct questions, answers and remarks to a particular person by looking at that person and by way of the context of the remark.

This result contrasts with that for the similarly sized, but two node videoconferences. While only one per cent of the comments made on the San Antonio system were name tagged, a quarter of the respondents to the questionnaire said that they were unable to always determine who was saying what and to whom. Difficulty in identifying who was speaking was exacerbated by the fact that three participants in each room were portrayed in the one image and thus the resolution of each individual's face was much poorer than for the Washington system. One user who had had previous experience of a large two node videoconference using the Picturephone Meeting Service (PMS) preferred the Washington system with virtual space. According to him the PMS videoconference had been very unsatisfactory because it had been impossible to follow who was saying what to whom. This information, which people take for granted in a face to face meeting, is vital.

The private-phone system was only used on four occasions during the real meetings. On two of these occasions someone used the phone to telephone an outside person. There was probably little need to hold a private conversation in the real meetings examined, which were primarily co-operative discussions. One user remarked that she would have used it to confirm the meaning of an acronym with her colleague, but felt it was too obtrusive a gesture for such a minor requirement.

6.3 Suitability of different types of meetings for videoconferences

Most of the groups using the system had views about the sorts of meetings that would be suitable for such treatment. It was not thought to be suitable for meetings with a high emotional content, such as job interviews. In addition the resolution was not thought adequate for training purposes. However, five groups felt the system would be very appropriate for briefings or local project meetings between peer groups of Majors or Colonels, but not more senior personnel. However, no one more senior than a Colonel was interviewed and perhaps Generals for example, would not have agreed with this assumption. Users said they would be more confident using the system if people senior to them were not present. Characteristics of meetings thought most suitable would appear to be those which take place frequently and whose purpose was primarily to co-ordinate and exchange information.

Talking about their own normal meetings, users commented that they usually only involved two or three people from one or two sites. The appropriateness of a five node system and virtual space would thus appear to be limited within the agencies' departments sampled. However the reason that few meetings presently take place between people from as many as five different sites, may well be an artefact of the difficulty of co-ordinating such events. Perhaps if the capability to easily hold multi-site meetings existed then more would take place and the benefits to the distribution and coordination of information in the Defense Department would be considerable. Overall, most participants said that they would not expect such a system to result in there being less travel, since the bulk of travel is for training purposes and for inspections of objects or documents. They commented that instead there would probably be better communications between personnel and departments.

There seems to be little requirement for videodiscs among the particular groups interviewed. They would like to come to a meeting with a hard copy agenda and maybe some text or graphics and enter them somehow onto the system. Once these are on the system the ability for all the users to annotate them simultaneously was thought to be useful. One user with a strategic role outside of Washington did see advantages in having maps of the world available on videodisc and very much liked the ability to access individual frames by typing in a place name. Others did not see such an immediate role for videodisc in their particular departments.

7. RELIABILITY OF THE EQUIPMENT

The equipment was still being developed during the course of the exercise. This meant that the evaluation exercise suffered in a number of ways. First, for a couple of days no meetings could be arranged while the system was being modified. Throughout the trial problems were encountered as a result of new improvements not working perfectly and the system not having been fully tested before, or even allowed to run for such long times.

The following is a list of the problems encountered during this exercise. However it is not anticipated that the final fully tested system would be so unreliable. Also recorded here are a number of improvements which had not yet been implemented.

- A maximum of only four sites could be fully interconnected via the SGVS. For most of the trial only the workstations in three sites were in communication. There were also other problems encountered with the SGVS concerning both the software and hardware components bought from elsewhere.

- A frequent problem which was encountered on one or more occasions during almost all the videoconferences was that one of the images would freeze. The sound was not affected. This fault was thought to be due to noise on the telephone company's digital lines disrupting one of the codecs and could be remedied by resetting it. There are plans to use a microcomputer to monitor all the lines between the locations and automatically reset the codecs if faults are discovered. Without such a capability, the videoconference system is not a robust one and thus does not fulfill one of the initial objectives for developing the 19.2 Kbit/s codecs in the first place.

- The facsimile interface had not yet been developed.
- The capability of erasing a line by simply reversing the stylus and then retracing over a line had not yet been completed.

Apart from the problems with the fourth and fifth workstations and with the codecs being disrupted by any noise on the digital lines, the equipment was reliable. The codecs otherwise worked well and there were no problems with the synchronisation of the images, for instance, as had been encountered in San Antonio. However, until the SGVS has been fully tested with all five nodes working it will be impossible to assess confidently its level of performance.

8. CONCLUSIONS

The chapter presents the conclusions drawn from the exercise. Those referring to the SGVS are discussed separately in section 8.2.

8.1 Five node videoconferencing

All but one of the real videoconferences were, by and large, satisfactory. However there were some objections about the quality of the audio and of the compressed video images. In addition several users doubted whether it would be acceptable to some senior and non-technical users who it was thought may not appreciate the technical sophistication and instead simply compare it unfavourably with normal broadcast television. Several actions may be taken to improve these aspects while not incurring the costs and complications of broadcast television.

The first step towards improving the audio quality would be to raise the threshold before howlaround sets in. Howlaround can be avoided by cutting down on the sound picked up by the microphones indirectly from the loud-speakers off the walls and ceiling. This can be achieved by putting non-reflective material on the walls which could be hidden, if necessary, behind curtains. Tie clip microphones had already been tried in an earlier version of the system as an alternative to the shotgun ones, but these had not performed any better than the directional ones and had the disadvantage that participants needed to be wired to the system and any extra observers in a room would have needed themselves to each have one if they had wished to be heard.

The clarity of the participants' speech can also be improved by reducing the ambient noise level. Since there is one live microphone at each site noise can be a problem in multi-site teleconferences with open audio. All sources of noise such as machinery, air conditioning and outside street noise should be located and their effect minimised. In the Washington system this was not a great problem, since the rooms used were not close to any major sources of noise. However, in most operational sytems this is likely to be more of a problem. In such a situation in addition to blanketing the effect of extraneous noise sources, some form of gain switching should be attached to the audio system.

When someone is not talking, the responsiveness of his, or her, microphone should be reduced so that it is not picking up and amplifying the noise in the room. When they start to talk the normal gain level can be restored. Such a gain switching is commonly used in audio teleconferencing and need not be as severe as voice switching whereby the microphone is either live, or off, and the beginning of remarks can be clipped slightly and lost.

DARPA have already helped develop a successor to Compression Laboratories 19.2 Kbit/s codec. The prototype codecs being produced by Widcom Inc work at 56 Kbit/s. These codecs can provide motion colour videoconferencing at this low data rate, by coding for any differences between frames instead of only filtering within each frame for detail and coding for any edges. Thus if an area is not moving, or moving slowly, great savings can be made in the information required to code the picture. When the image is still, or areas of it are only moving slowly, the resolution is very good and colour diagrams, for instance, can be held up in front of the camera and be clearly seen at a remote site. After half of the sessions, users were shown a videotape presentation of the picture quality of the Widcom codec. This was in all cases very well received. Although the rate at which frames are replenished and its ability to cope with motion are worse than for broadcast television, they were thought to be adequate for videoconferencing. It was certainly preferred to the compression laboratory's codec. The proposed cost of these new codecs (about $65,000) is however greater than that for the sketch coders (about $25-30,000).

By using the Widcom codec and improving the audio treatment of rooms, the system would be much improved and be satisfactory for most users. However, the remaining issue is whether the benefits drawn from the virtual space concept are worth the extra costs involved.

If there are n sites, to create the virtual space effect, 2n(n-1) video links are required. However in the Arlington system, the five nodes in fact located in only three buildings. These are connected in a series by pairs of 56 Kbit/s lines. The video signals are multiplexed together with those for the SGVS. Even so the monthly communications cost is $6,000. The monthly communications cost for linking the single codec and SGVS in San Antonio to those in Washington D.C. is $10,000. The cost of connecting five widely dispersed sites and creating a virtual space effect would be considerable.

A problem encountered when using the virtual space system is that time has to be spent in the beginning of the meeting getting new users to sit in a position where they are visible to all the remote sites. Effort is needed to maintain a near steady position and during a meeting some participants would tend to drift out of camera shot as they leant on the desk, used the SGWS or leant backwards. Half way through the trial the camera lenses and codecs were adjusted so as to widen the field of view. This improved the likelihood of people staying on camera at the expense of their appearing smaller on the screen. However this also increased the time lag between the video and audio signals. It is possible to delay the audio signal so as to synchronise it with the video, but this makes the rapid exchange of comments in a videoconference difficult, especially when combined with delays due to use of satellites. The optimal solution must be to reduce this time taken by the codecs to process the visual information.

Monitors showing how a participants appear to each of their colleagues would enable them to correctly centre themselves and could prompt them to remain so positioned. Four of these self views would probably be required to confidently do this. If small monitors are used, they need not be distracting, especially if the view shown on them is a mirror image, i.e. the one people are most used to seeing of themselves. The small self view monitors could be grouped together in front of the participants so that they can easily check their position in one glance. Otherwise the only way to guarantee that all participants remain in camera shot is to make the cameras to some extent steerable and to have outside camera operators.

It will be desirable in some meetings for more than one person at each site to be able to take an active role. At present, because of the lenses used and their convergence onto a single point, only one person can easily be positioned so as to be clearly visible to all the other participants. Probably the best way round this would to be able to switch to one central camera, arranged for a group shot of up to three people sat side by side. All the remote sites would then get the same group view of a site with more than one person. The virtual space would only suffer slightly if there was only one such group site at a time in a meeting. If each site has more than one person, the meeting would be a large one and even if the participants were sat around a table the effect would be less of a meeting and more of a presentation or briefing.

8.2 Shared graphics work space

For most of the time only three nodes were fully interconnected by the SGWS, although for the last few days four nodes were connected. Therefore it was not possible to test fully how satisfactory the SGWS was since not all the participants were able to access it at the same time and thus it was not used in the real five node meetings except experimentally. However, many conclusions can be drawn. Firstly, a problem which beset the two node system, its speed of response was not reported as a problem here. The speed which one can move from page to page, draw lines and erase them is much improved. However, it should be possible to skip to a page without having to display all the intervening ones. For example, five rapid taps of the 'next page' key should result in the frame five pages forward being directly displayed at all sites.

The system was very simple to use. The only problem encountered was when users inadvertently got into indicate mode and then attempted to write. When a colour ink key is pressed once it lights up and the user can write in that colour. When it is pressed again, it remains lit up while operating in indicate mode. A better procedure would be for the light to go out or flash when in indicate mode. In addition, some of the keys, especially the blue one, are not at all bright when lit. If each of the keys was informally bright when illuminated and ready for writing then the method of working of the system would be self evident. When the system is first powered on, it is in indicate mode. It would be better instead if each station was ready to write in blue for example.

The other keys such as 'next page' and 'last page' created no problems. The system works in a way such that if more than one person hits the 'next key' or 'last key' at the same time, it faithfully carries out both, or all commands. Therefore, a user may hit the 'next page' key once and be surprised when it moves ahead two pages, or forward once and back once, because someone else had also hit a key. It would be preferable if a minimum delay had to expire before a second person was able to press a 'next page' or 'last page' key. This delay should be equal to the time taken to display a page. A person should still be able to rapidly move forward and/or back through the pages, but there is no advantage in allowing a second person's commands to be executed before the current state of affairs has been established.

The ability for many people to have equal control over the system is otherwise a good feature of the system. However, it should be possible for a participant to establish at the beginning of the meeting a superior role whereby only the chairman, or presenter, of a meeting can change the page being currently displayed. In a formal presentation it should not be possible for the audience to skip between pages and therefore disrupt the meeting. There is no harm in still allowing all the users to draw or write on the system, but there are situations when there should be some constraints on the democratic manner in which the system normally works.

The design of the SGWS console can be improved. Half the users criticised two aspects of its design. At present its horizontal orientation and height mean that it is difficult to read because of glare off the surface and too low to write on without moving out of camera shot. The advantage of having it on a separate console is that it does not get in the way of paper documents on the desk and does not obstruct leg movement underneath. It would however be easier to use if the wooden frame around the monitor were not so wide, forcing one to reach out to the side further than is necessary. In the longer term, the next generation of flatter display tubes should enable more flexibility, allowing some users to position the SGWS on the desk while others may want to retain its present position to one side.

A second SGWS monitor should be available to allow observers to see easily what is being displayed, without having to look over the shoulders of the main participant.

At present there are 20 pages with background images from the videodiscs and text and graphics stored on a magnetic disc. These can be selected and displayed by the users at their workstations. However preparing the text and graphics and selecting which of the 50,000 or so videodisc frames are to be included in these 20 pages takes place at one central location. The necessary procedure is not a user friendly one and is not suitable for people with no experience of computers. This is obviously not a satisfactory state of affairs for if and when the system is installed in a real operational context.

It should be possible for fairly naive users to be able simply to type in text ahead of the meeting at any one of the five nodes. It would be desirable for the system to have a standard interface with word processors. Similarly, users should be able themselves to select videodisc frames easily both during a meeting and prior to it and be able to equate a videodisc frame number with a page number so that whenever that page is selected the relevant frame is displayed.

Other enhancements which are already due to be implemented are essential if the system is to be useful. There must be a facsimile interface so that people can bring hard copy documents to the videoconference and have them appear on the SGVS. Furthermore, 20 pages is not adequate. For facsimilied text to be easily readable when displayed on a monitor the maximum amount, if an ordinary type face is used, is about half a quarto page. Therefore at present documents of over 10 pages long are too large to be facsimilied and displayed on the screen. Users should be forewarned about the desirability of using a large bold typeface when preparing agendas, for instance, which are to be presented in such a way. The best way of preparing text pages would however be for them to be either re-keyed, onto the system or for a floppy disc, for instance, containing the text to be brought to the meeting ahead of time and for this to be then read directly onto the system.

A final complaint about the SGVS is that the curvature of the monitor makes writing on it diffi ılt. Other VDU's exist which do not have such a degree of curvature.

8.3 General Conclusions

At present the whole videoconference system has been designed so as to be easy to use. Controls for the volume and contrast levels, the preparation of the 20 SGWS pages, the establishment of the videoconference and its resetting when faults occur all take place outside of the studio. The result of taking this decision is that there is a need to have one person per site supporting the videoconference. Not only does this increase the cost of the system, but also may have some implications for its security. It is planned to encrypt the voice, video and SGWS channels between sites. However, aides will have to monitor the sound and video, certainly during the early stages of the meeting, so that the correct levels are maintained. For more secure uses, users would have more confidence in the system if they knew no one outside the five studios was following the conversation. This would require a removable control panel in each studio containing four volume controls and four contrast controls. In addition it should be possible to move the facsimile interface into the studios themselves so that the users can again be confident that they know exactly what is going on at all stages.

For the majority of meetings, however, it would be preferable to keep such equipment outside in a separate room so as to cut down on the noise level in a studio.

APPENDIX A

THE QUESTIONNAIRE

EIU INFORMATICS

Spencer House, 27 St James's Place, London SW1A 1NT Telephone 01-493 6711 Telex 266353

Teleconference Questionnaire

Please spend a few minutes, after you have finished your teleconference, filling in this questionnaire. In most cases, questions can be answered by simply checking the appropriate box. Any comments would be very welcome.

NAME........................... DATE ....

RANK/GRADE.................... DEPARTMENT.............

BUILDING AND ROOM NO.
SAT IN DURING TELECONFERENCE:..........................

A. MEETING TYPE

This section examines the nature of the meeting you have just held.

Which of the following categories best describes the meeting?

You may tick more than one box

- ☐ Presentation of ideas or views
- ☐ Problem solving
- ☐ Ideas generation
- ☐ Discussion
- ☐ Negotiation
- ☐ Exchanging information

B. YOUR PERCEPTION OF MEETING PERFORMANCE

Below, there is a list of the factors which describe a business meeting. Indicate whether the teleconference you have just participated in showed an increase or decrease in each attribute compared to your experience of similar face to face meetings. Also indicate the importance of each factor.

Important	Not important	Importance of each factor / Change due to Teleconference	Large decrease	Small decrease	No change	Small increase	Large increase
		Your satisfaction with the meeting					
		Length of the meeting					
		Information accessibility					
		Sense of privacy/security					
		Effectiveness					
		Decision quality					
		Task orientation					
		Cooperation of participants					
		Aggression					
		Friendliness					
		Peoples' preparation					
		Own Contribution					
		Own control over the meeting					

C. THE EQUIPMENT

Now please consider the performance of the equipment you have just used.

TELECONFERENCE EQUIPMENT	Satisfactory	Not satisfactory	Any comments
Loudness			
Sound quality			
Clarity of picture			
Movements of the image			
Ability to determine:			
a) identity of the participants			
b) who was speaking			
c) who was being spoken to			
THE SHARED GRAPHICS WORK SPACE			
Ease of use			
Readability			
Speed of response			
Ability for more than one person to use it at a time			

D. USE OF CONTROLS OR FACILITIES

Indicate whether you personally used each of the following controls of facilities, and, if so, how useful were they? Did any distract your attention from the meeting?

Whether used: Yes	No		usefulness of facility: Very useful	Quite useful	Not useful	Distracting
		Use shared workspace				
		Point to a position on the screen/or pad				
		Use colours				
		Use eraser				
		Select background from:-				
		a) videodisc				
		b) overhead camera				
		c) stored pages by page number				

Would you like to make any other comments about the teleconference or the equipment you have just used?